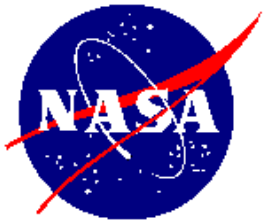


Space Shuttle Return to Flight (RTF) Status

Mike Wetmore
October 15, 2003

CAIB Report

CAIB Report released August 26, 2003

- 29 recommendations including 15 Return To Flight recommendations

NASA Policy is to:

- Accept the findings
- Comply with the recommendations
- Embrace the Report

NASA responded with Return to Flight Implementation Plan which detail response plan and current status

- Next release is mid-October

Web sites:

- CAIB http://www.nasa.gov/columbia/home/index.html
- RTF http://www.nasa.gov/news/highlights/rtf_plan_092003.html

15 Return To Flight Recommendations

3.2-1	External Tank (ET) Debris Shedding
3.3-2	Orbiter Hardening
3.3-1	Reinforced Carbon Carbon (RCC) Structural Integrity
6.4-1	Thermal Protection System (TPS) On-Orbit Inspect and Repair
	Tile Inspect and Repair
	RCC Inspect and Repair
3.4-1	Ground-Based Imagery
3.4-2	Downlink Post-Separation
3.4-3	On-Vehicle Ascent Imagery
6.3-2	National Imaging and Mapping Agency (NIMA) Memorandum Of Agreement (MOA)
4.2-1	Solid Rocket Booster (SRB) Bolt Catcher
4.2-3	Closeout Inspection
4.2-5	Foreign Object Debris (FOD) Process
6.2-1	Scheduling
6.3-1	Mission Management Team (MMT) Improvements
9.1-1	Detailed Plan for Organizational Changes
10.3-1	Digitize Closeout Photographs

STS-114 Launch

Launch date recently moved to NET September 2004

Date is achievable, but success oriented

Biggest Challenges

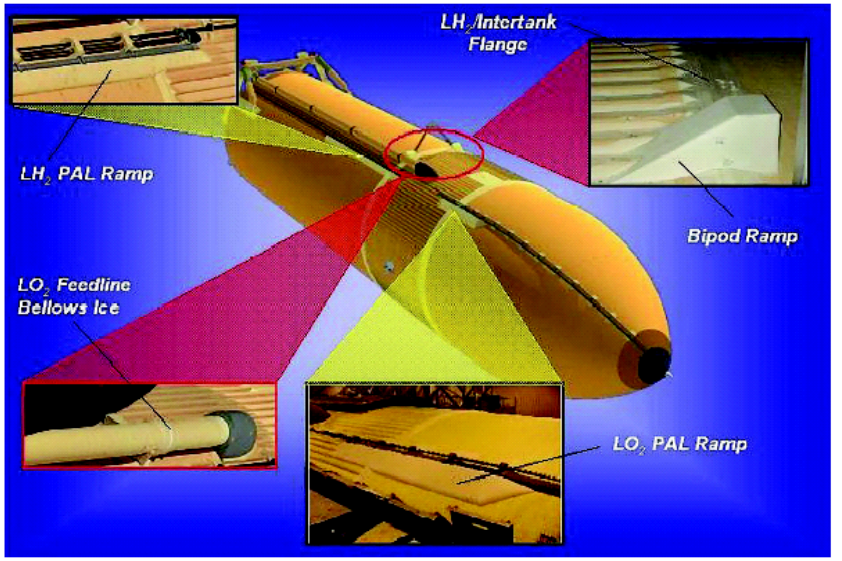
External Tank Debris Shedding (Recommendation 3.2-1)

TPS on-orbit inspection and Repair (Recommendation 6.4-1)

Detailed Plan for Organization Changes (Recommendation 9.1-1)

Recommendation 3.2-1

Initiate an aggressive program to eliminate all External Tank (ET) Thermal Protection System (TPS) debris-shedding at the source with particular emphasis on the region where the bipod struts attach to the ET. [RTF]



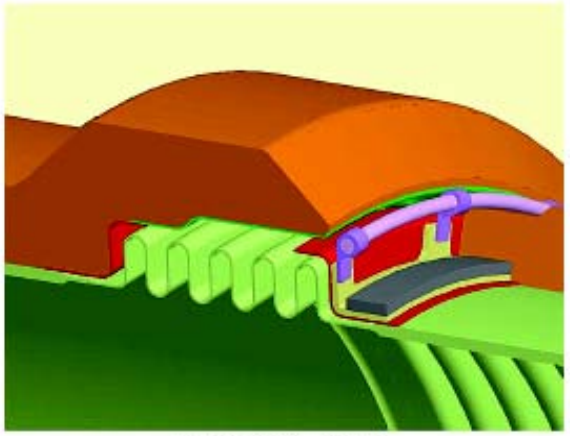
- NASA's work will focus on six areas:
  - Forward Bipod Ramp
  - LO2 Feedline Bellows
  - Protuberance Airloads (PAL) Ramps
  - LH2/Intertank Flange Closeout
  - Foam Verification Reassessment
  - Nondestructive Inspection (NDI) for foam
- *Forward Bipod Ramp* NASA has redesigned the forward bipod ramp to eliminate the need for a large foam ramp and has incorporated redundant heaters.
- *LO2 Feedline Bellows* NASA is examining means of eliminating ice in the LO2 feedline bellows, including a boot, drip lip and drain, and a purge ring.
- *PAL Ramps* NASA is studying options to eliminate the ramps as sources of debris, including verifying the existing design, replacing the ramps, or eliminating the ramps.

(*continued on next page)*

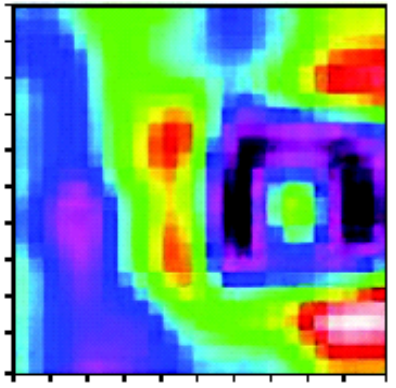
Recommendation 3.2-1 (cont.)

- *LH2/Intertank Flange Closeout* Options include a localized gas purge, sealing the flow path, improving TPS closeout to prevent voids, and minimizing post-manufacture damage.
- *Foam Verification Reassessment* NASA will create a prioritized list of debris-critical TPS applications, assess existing verification data, and establish requirements for data to provide added confidence.
- *Nondestructive Inspection (NDI)* NASA will survey state-of-the-art technologies, evaluate their capabilities, down-select, and qualify a system that will detect critical flaws in ET insulation systems. Systems being considered include:
  - **Backscatter Radiography***
  - Microwave Radar
  - Laser Shearography
  - **Terahertz Imaging***
  - Laser Doppler Vibrometry

*Best chance of success based on initial tests



Heated GN_2 Purge



1 in. SOFI to AL delaminations imaged with Backscatter Radiography

Recommendation 6.4-1

Develop inspection and repair capabilities for International Space Station (ISS) missions and non-ISS missions with the objective of a fully autonomous Shuttle capability. Perform on orbit TPS inspection early in all missions. [RTF]

- Short term
  - Redesign Shuttle components to eliminate critical debris
  - Improve ground and in-flight imaging capabilities to detect and assess damage
  - Develop techniques for repairing tile and RCC on orbit using Extravehicular Activities (EVAs)
  - Establish contingency procedures to keep Shuttle crew safely on board the ISS while repairs/rescue are being performed
- Long term
  - Provide autonomous Shuttle inspection and repair capability prior to the next Hubble Telescope servicing mission
- NASA has completed
  - Concept definition for a boom that can be added to the Remote Manipulator System (RMS) for viewing damage
  - Design and initial feasibility testing of TPS repair materials and techniques
  - Quantifying required image resolution

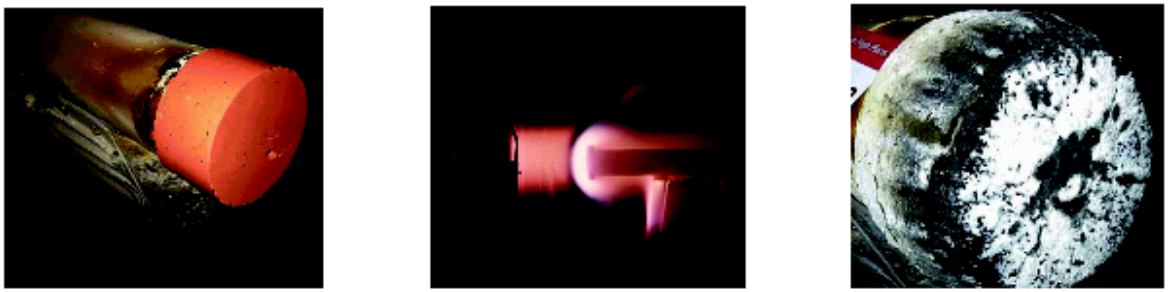


Figure 6.4-1-4. Tile repair material before, during, and after arc jet testing at 2300°F.

Recommendation 9.1-1

Prepare a detailed plan for defining, establishing, transitioning, and implementing an independent Technical Engineering Authority, independent safety program, and a reorganized Space Shuttle Integration Office as described in R7.5-1, R7.5-2, and R7.5-3. In addition, NASA should submit annual reports to Congress…on its implementation activities. [RTF]

- NASA will develop a comprehensive plan with concrete milestones implementing CAIB recommendations 7.5-1 through 7.5-3.
- Over the next several months, we will report to Congress our progress on development of options and milestones.
- We will implement these changes as soon as possible. As we do so, we must take time to understand and address the additional risk posed by these significant changes.
- Forward work includes
  - investigating funding paths
  - determining requirement ownership
  - identifying certification of flight readiness responsibility
  - specifying responsibility within the Space Shuttle Program for cost, schedule, and technical issues
- NASA recently established the NASA Engineering and Safety Center (NESC) at Langley Research Center to provide independent engineering and safety assessment.

Range Impacts

Recommendations affecting Range Support/Scheduling

- **Ground based Imagery (Recommendation 3.4-1)**
- **Derived requirement for daytime launch and ET separation to support photo requirements**

Potential use of Radar for Debris Characterization is also under study

Recommendation 3.4-1

Upgrade the imaging system to provide three useful views of the Shuttle from liftoff to Solid Rocket Booster (SRB) separation. [RTF]

- NASA is developing an integrated suite of improved imagery capabilities that will operate through launch, on-orbit operations, and landing.
- Launch Commit Criteria (LCC) are being developed, and will ensure an improved damage detection and engineering assessment capability.
- For the time being, Shuttles will be launched in daylight through ET separation.
- NASA is working with United States Air Force (USAF) to evaluate and improve use of ground assets.
- In addition to providing information about debris, these capabilities will provide detailed information on Shuttle systems.

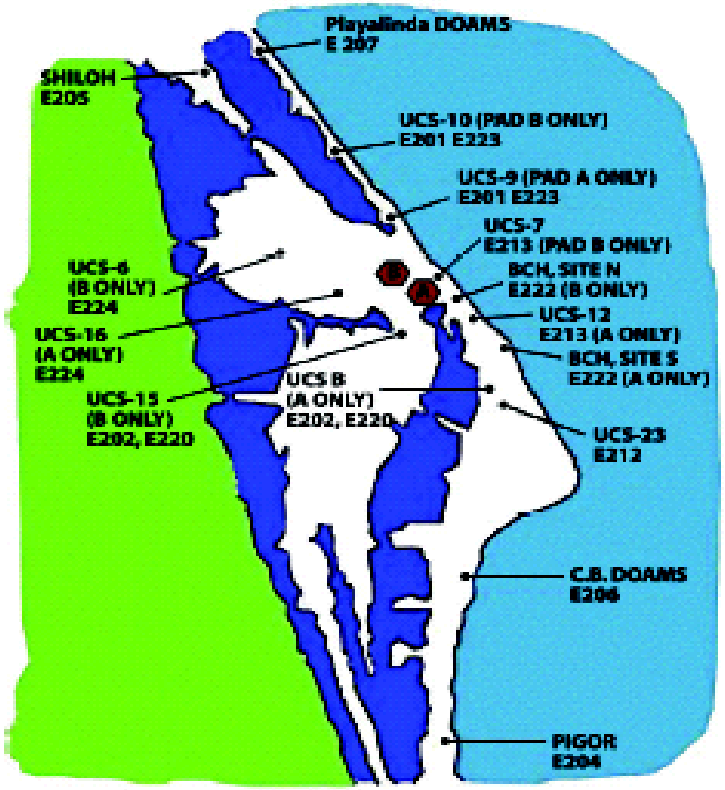
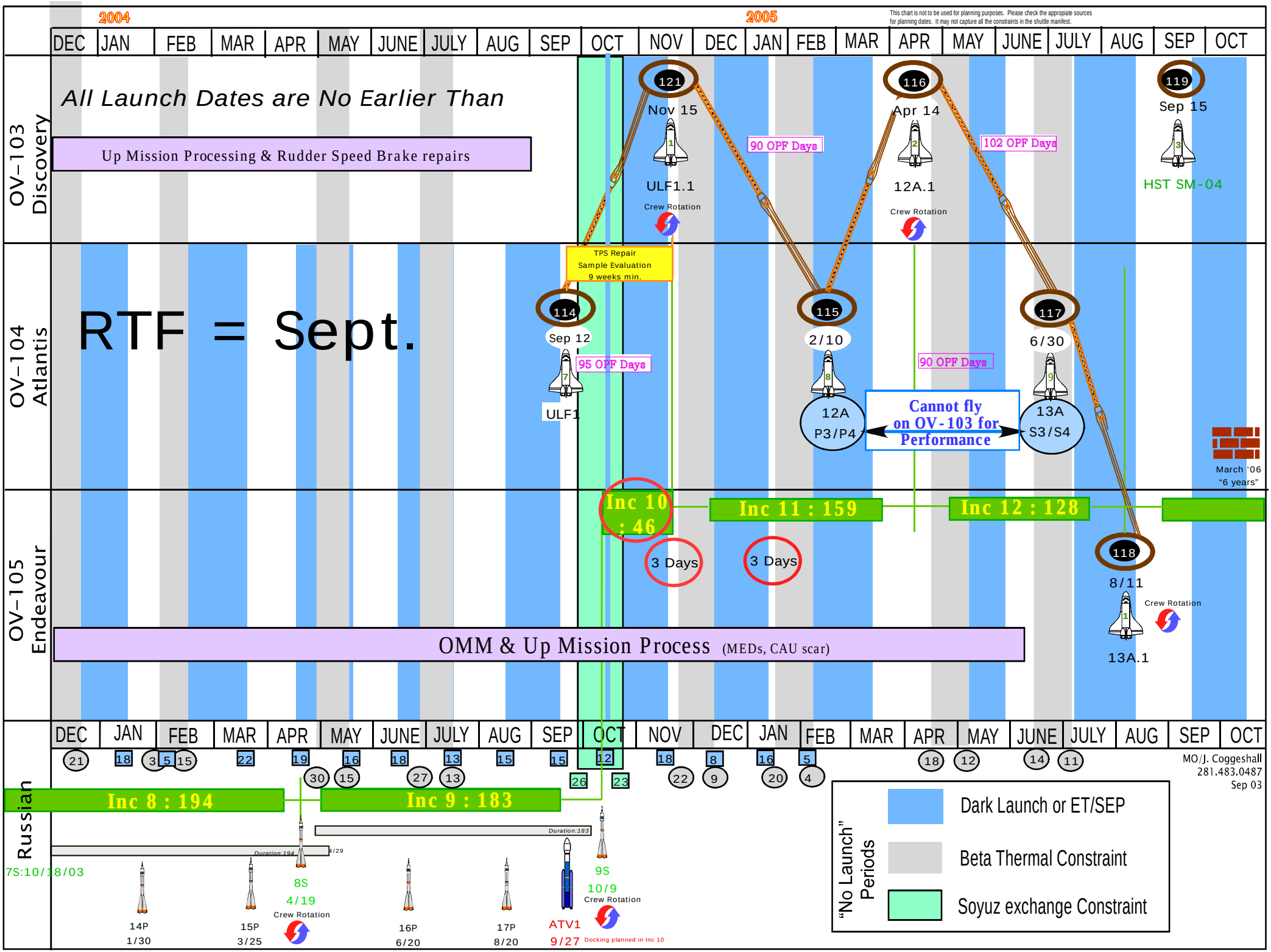
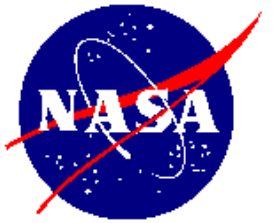


Figure 3.4-1-3. Medium- and long-range tracker sites.

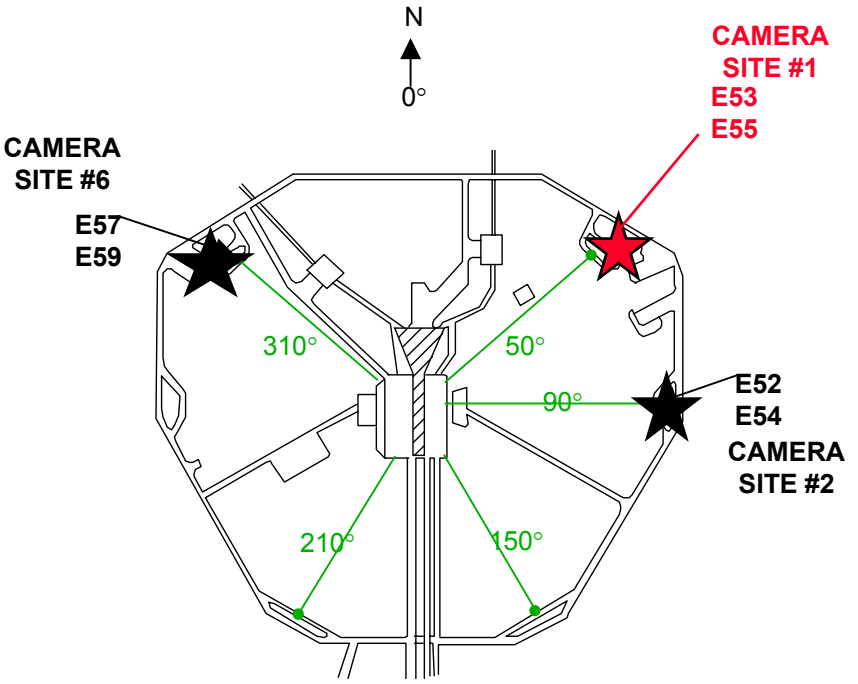

2004
2005
This chart is not to be used for planning purposes. Please check the appropriate sources for planning dates. It may not capture all the constraints in the shuttle manifest.
DEC JAN FEB MAR APR MAY JUNE JULY AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUNE JULY AUG SEP OCT
OV-103 Discovery
OV-104 Atlantis
OV-105 Endeavour
Russian
All Launch Dates are No Earlier Than
Up Mission Processing & Rudder Speed Brake repairs
RTF = Sept.
121 Nov 15
ULF1.1
Crew Rotation
90 OPF Days
116 Apr 14
12A.1
Crew Rotation
102 OPF Days
119 Sep 15
HST SM-04
TPS Repair Sample Evaluation 9 weeks min.
114 Sep 12
95 OPF Days
ULF1
115 2/10
12A P3/P4
90 OPF Days
Cannot fly on OV-103 for Performance
117 6/30
13A S3/S4
March '06 "6 years"
Inc 10 : 46
3 Days
Inc 11 : 159
3 Days
Inc 12 : 128
118 8/11
Crew Rotation
13A.1
OMM & Up Mission Process (MEDs, CAU scar)
21 18 3 5 15 22 19 30 15 16 18 27 13 13 15 15 26 12 23 18 22 8 9 16 20 5 4 18 12 14 11
Inc 8 : 194
Inc 9 : 183
Duration:194
Duration:183
7S:10/18/03
14P 1/30
15P 3/25
8S 4/19
Crew Rotation
16P 6/20
17P 8/20
ATV1 9/27
Docking planned in Inc 10
9S 10/9
Crew Rotation
"No Launch" Periods
Dark Launch or ET/SEP
Beta Thermal Constraint
Soyuz exchange Constraint
MO/J. Coggeshall 281.483.0487 Sep 03



BACK-UP

Short-range Trackers (proposed) (T-10 through T+57 sec)

- Trackers
  - E52 200mm (7.8")FL 100fps 400' film load
  - E54 200mm (7.8")FL 100fps 400' film load
  - E57 200mm (7.8")FL 100fps 400' film load
  - E59 200mm (7.8")FL 100fps 400' film load
  - E53 200mm (7.8")FL 100fps 400' film load
  - E55 200mm (7.8")FL 100fps 400' film load
    - Addition of this tracker ensures view of area between ET and Orbiter during roll maneuver to track any debris.

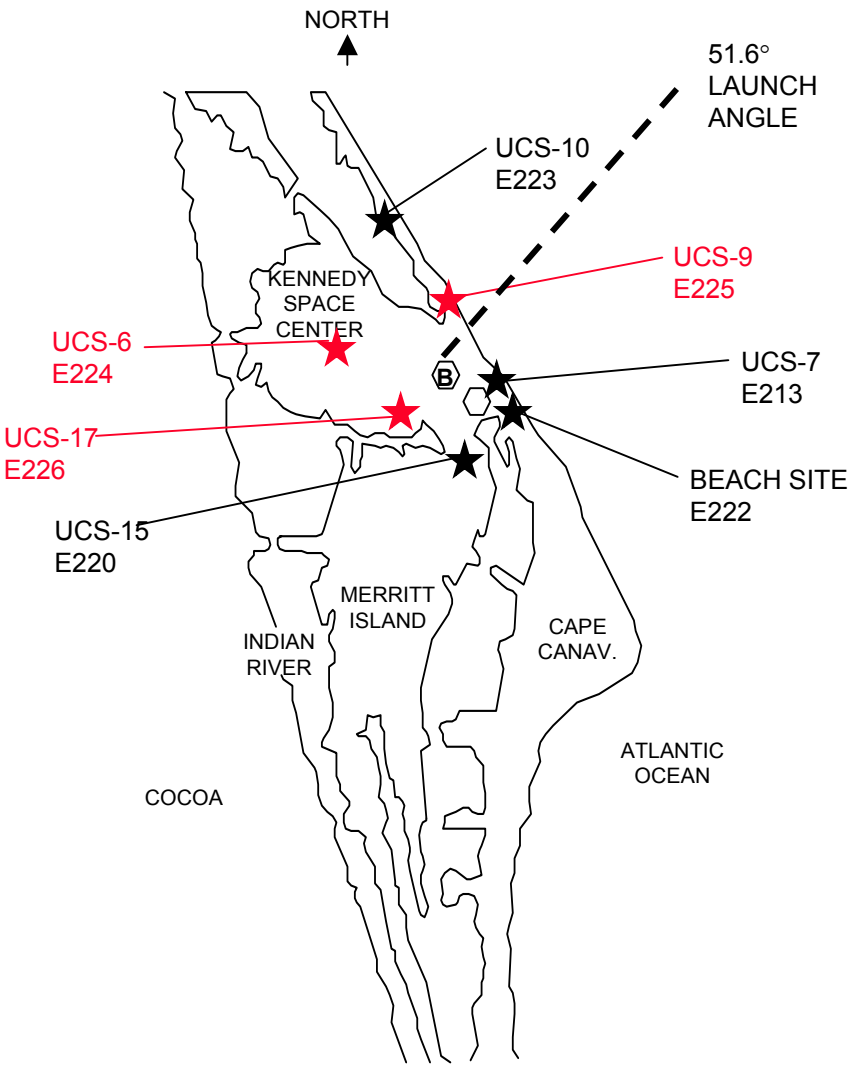


- <u>No affect on any Range Safety System hardware due to these changes</u>

Medium-range Trackers (proposed) (T-7 through T+110 sec)

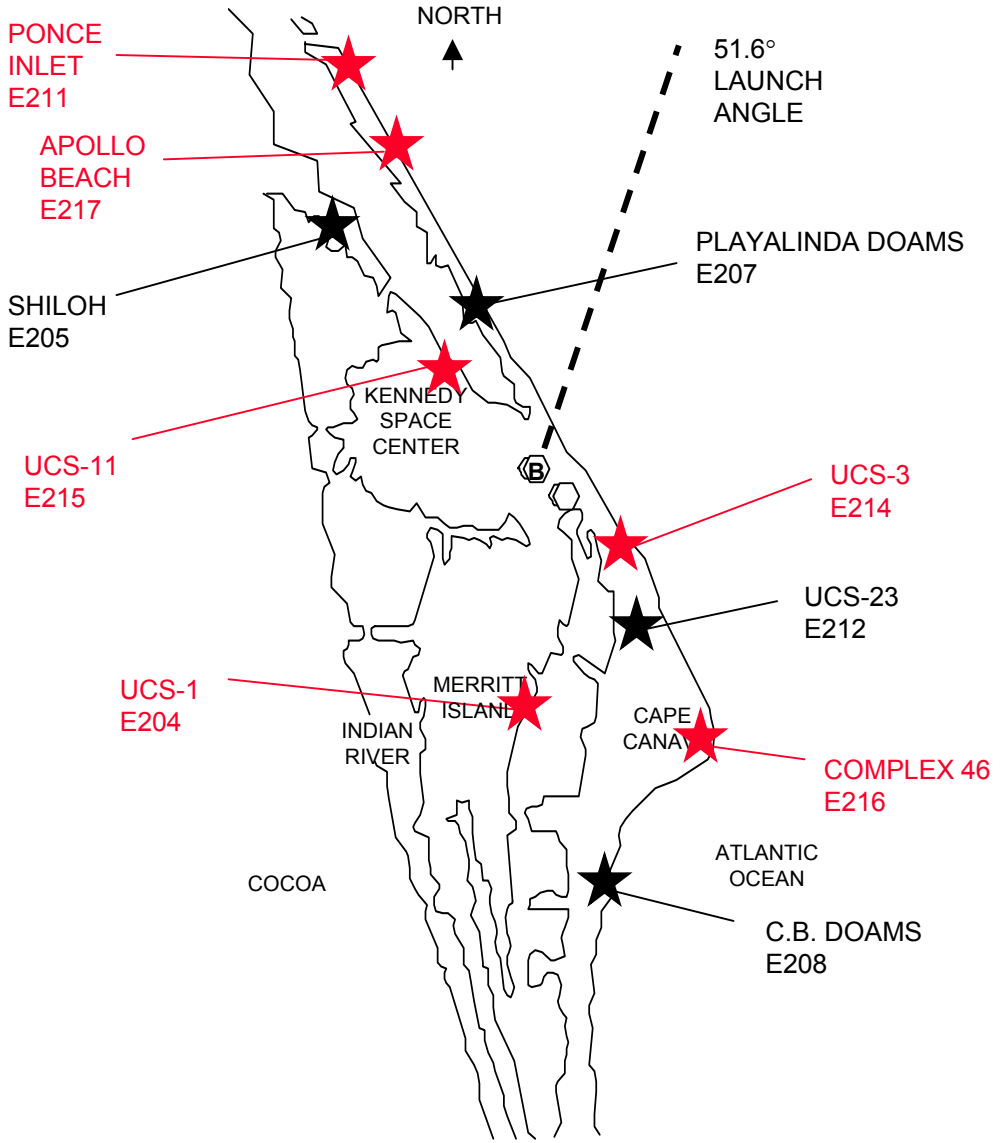
- E213 MOTS 800mm (32") 100fps 400' film load
  - 1 mile from pad
- E220 KTM 120" 100fps 1000' film load
  - 3.5 miles from pad
- E222 KTM 800mm (32") 100fps 400' film load
  - 2.25 mile from pad
- E223 KTM 80" 100fps 1000' film load
  - 6 miles from pad
- E224 KTM 150" 100fps 1000' film load
  - 3.5 miles from pad
- E225 KTM 150" 100fps 1000' film load
  - 3 miles to pad
- E226 KTM 150" 100fps 1000' film load
  - 2.25 miles from pad

- **No affect on any Range Safety System hardware due to these changes**



Long-range Trackers (proposed) (T-7 sec or AOV through T+165 seconds)

- North
  - E205 KTM 400"FL 100fps 1000' film load
    - 14 miles from pad
  - E207 DOAMS 400"FL 100fps 1000' film load
    - 7.75 miles from pad
  - E211 KTM 400"FL 100fps 1000' film load
    - 38 miles from pad
  - E215 KTM 400"FL 100fps 1000' film load
    - 8 miles from pad
  - E217 KTM 400"FL 100fps 1000' film load
    - 20 miles from pad
- South
  - E206 ATOTS 400"FL 100fps 1000' film load
    - 12 miles from pad
  - E208 DOAMS 400"FL 100fps 1000' film load
    - 20 miles from pad
  - E212 ATOTS 400"FL 100fps 1000' film load
    - 9.5 miles from pad
  - E214 KTM 400"FL 100fps 1000' film load
    - 4.75 miles from pad
  - E216 KTM 400"FL 100fps 1000' film load
    - 11 miles from pad



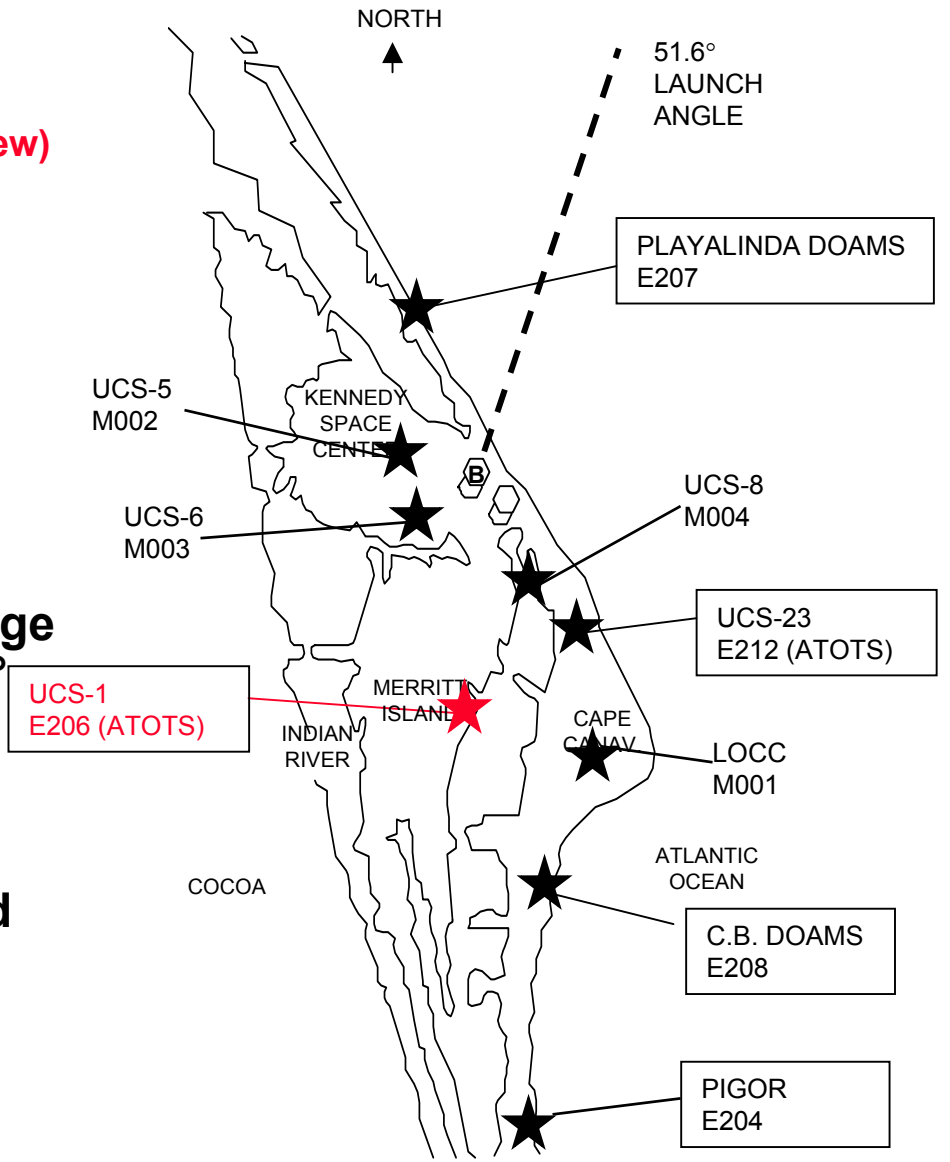
Range Safety System Metrics Trackers

Presenter: Mike Wetmore

	WAS	Proposed
• ET204 PIGOR	120”	NTSC Video > HDTV
• ET206 ATOTS	60”	NTSC Video > HDTV (new)
• ET207 DOAMS	200”	NTSC Video > HDTV
• ET208 DOAMS	200”	NTSC Video > HDTV
• ET212 ATOTS	60”	NTSC Video > HDTV
• M001 Contraves	60/120”	NTSC Video n/c
• M002 Contraves	60/120”	NTSC Video n/c
• M003 Contraves	60/120”	NTSC Video n/c
• M004 Contraves	60/120”	NTSC Video n/c

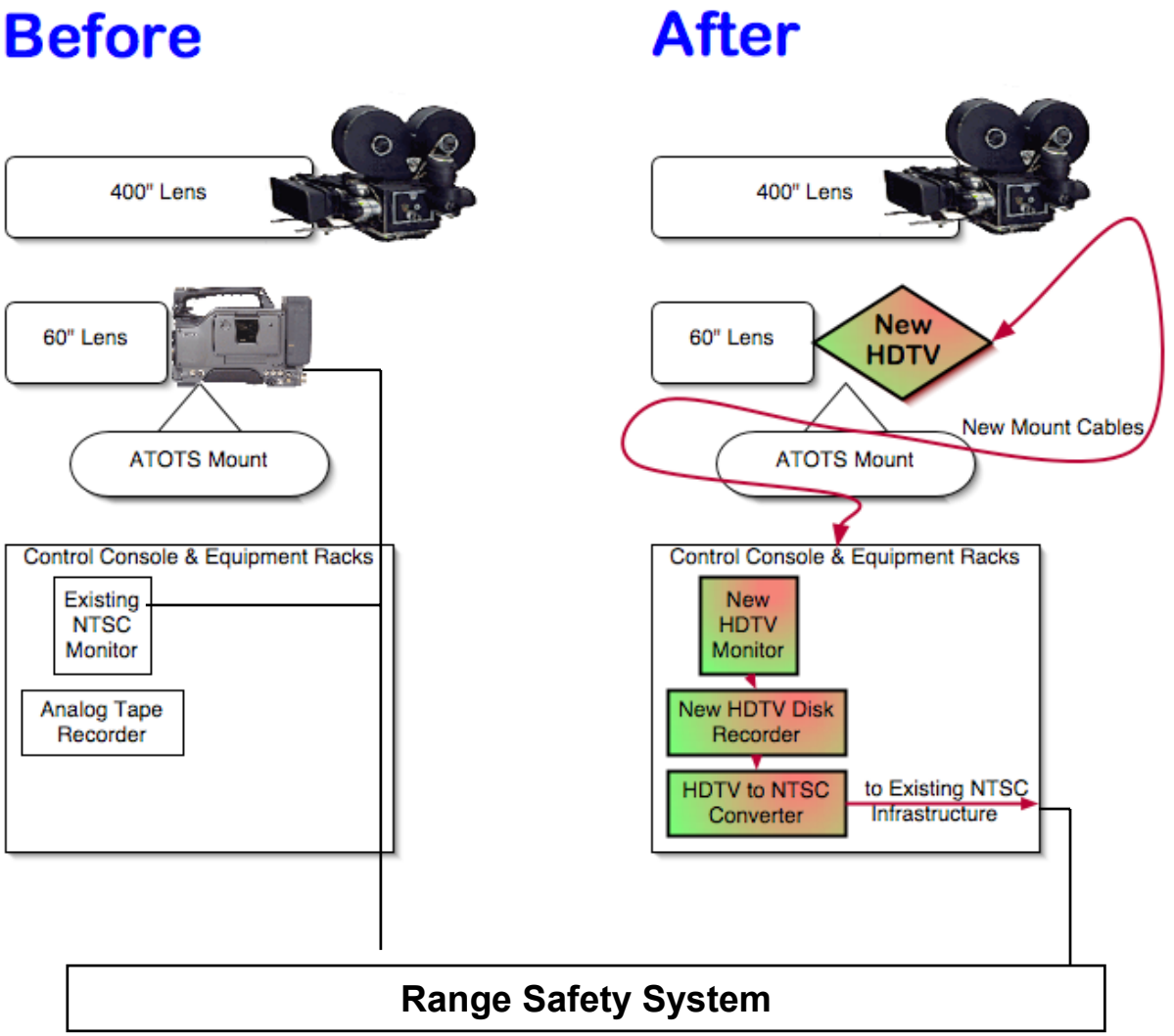
- **Patrick PIGOR will not be used for image data by the Shuttle Program for a 51.6° inclination. It can still be used by the RSS.**

- **The second ATOTS (ET206) is new and will be available for use in a RSS solution.**



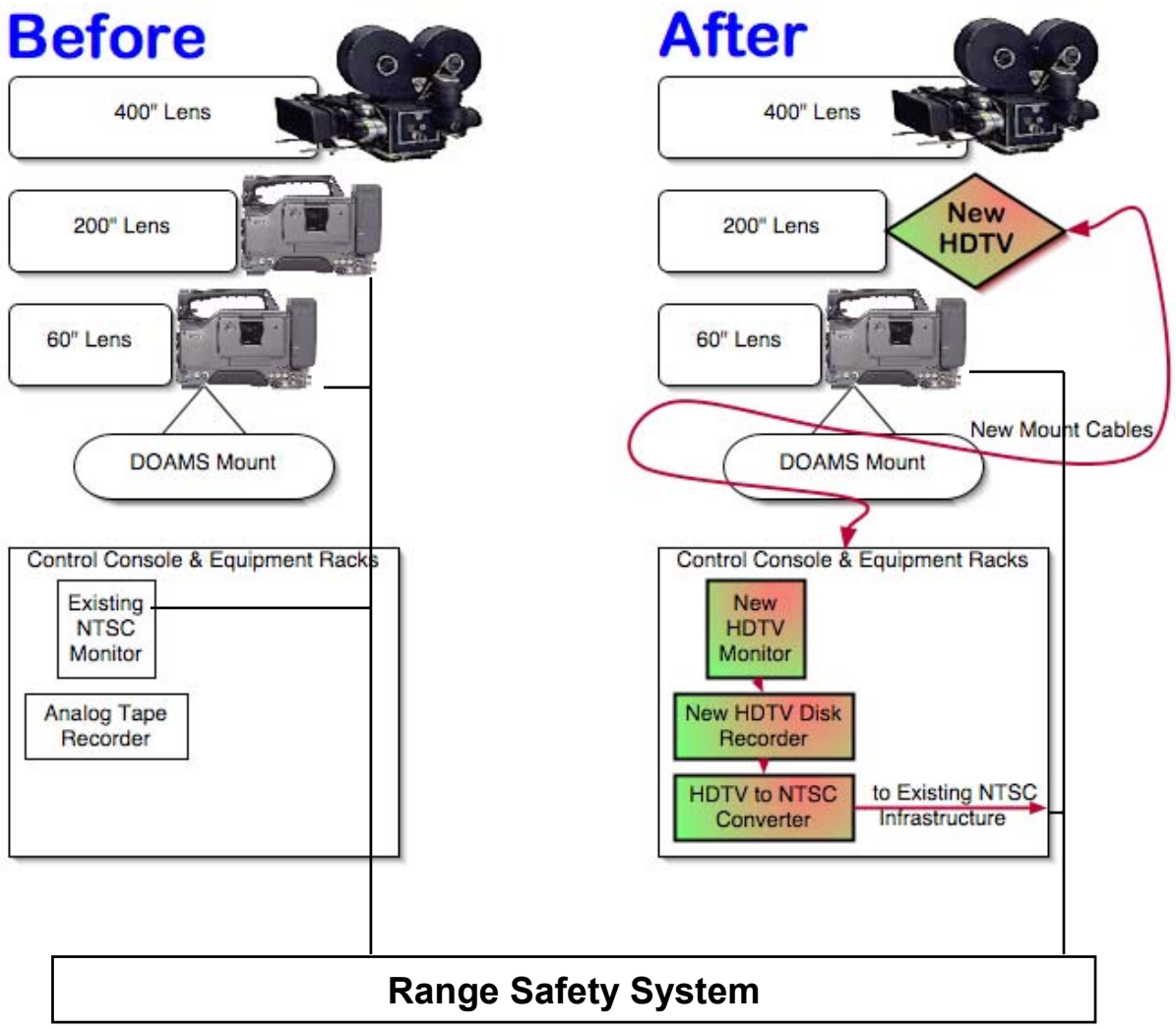
ATOTS Changes

- Changes
  - Replace NTSC video camera with HDTV camera
  - New HDTV cabling
  - Replace MII recorder with HDTV Recorder
  - Install new HDTV monitor
  - Install new HDTV to NTSC converter
  - Reroute NTSC cabling for RSS



DOAMS Changes

- Changes
  - Replace NTSC video camera with HDTV camera
  - New HDTV cabling
  - Replace MII recorder with HDTV Recorder
  - Install new HDTV monitor
  - Install new HDTV to NTSC converter
  - Reroute NTSC cabling for RSS



Mobile Assets

- Investigation of the feasibility of aircraft or ship based imaging assets is still underway.

- Considerations:
  - Range Safety approach distance
  - Equipment capability/availability

- Discussions continue about
  - Ships
    - USNS Waters
  - Aircraft
    - NASA WB-57F with Skyball imager